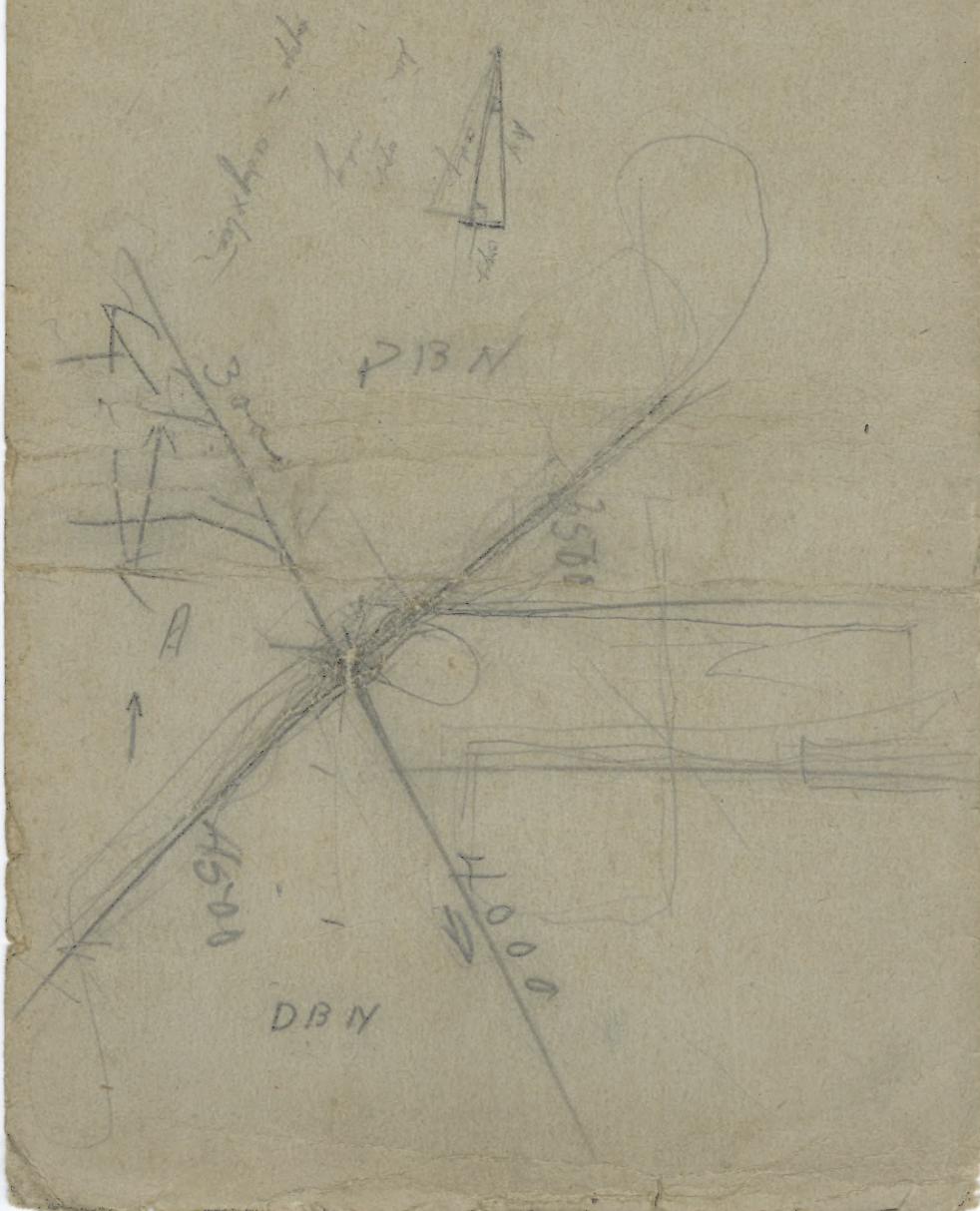
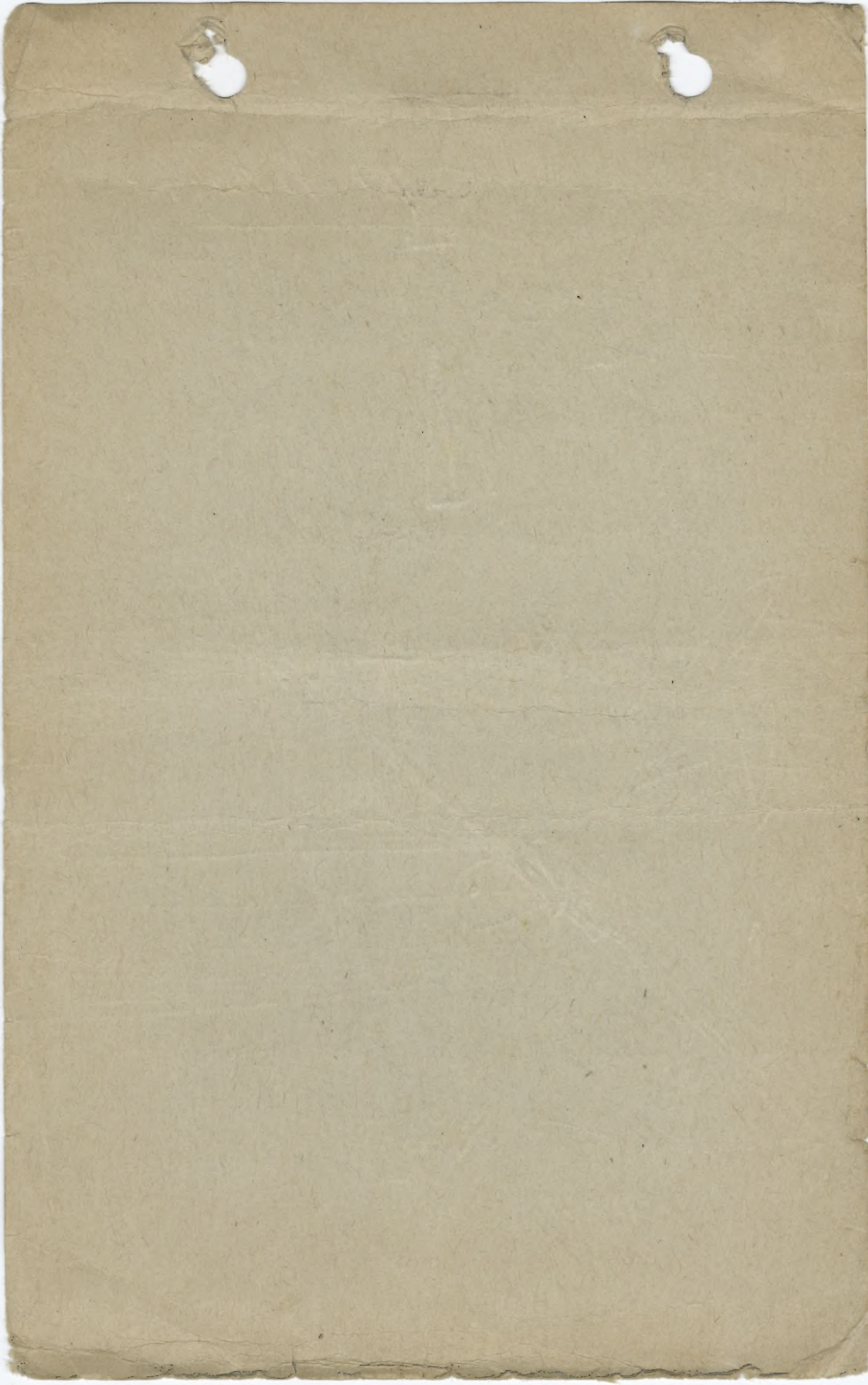


Capt. Mason





LESSON I.

Lesson #1

OBJECTIVE

To familiarize the student with instrument flying in the advanced trainer. To explain the radio range network and general principles of radio range flying. To demonstrate the various range signals.

SEQUENCE OF INSTRUCTION

1. BEFORE TAKE-OFF

- a. Explain purpose of the radio range and principles of range navigation.
- b. Explain the signal pattern of the radio range and how they are interpreted to determine location of the aircraft.
- c. Explain proper tuning procedure.

2. LESSON IN AIRPLANE

- a. Student repeats cockpit check over the interphone.
- b. Student makes instrument take-off and executes climbing turns to working altitude.
- c. Conduct a review of Basic Instrument Flying.
- d. Demonstrate Proper Tuning Procedure.
- e. Demonstrate the Radio Range Signal Pattern.

Lesson #1

- (1) Clear quadrant.
- (2) Bi-Signal Zone.
- (3) On-Course Signal.
- (4) Cone of Silence.

- f. Demonstrate Build and Fade and the necessity of volume control.
- g. Constant let-down to field; land and hold critique.

INSTRUCTOR'S GUIDE TO LESSON-I

. BEFORE TAKE-OFF.

- a. Explain to the student that the relation between instrument and contact navigation is similar to the relationship between instrument and contact basic flight. Navigation consists primarily in flying from point to point along the most expeditious route and the requirements for such navigation are identical whether the flight is being conducted by instrument or contact reference. Basically, the pilot is required constantly to identify the position of the aircraft with respect to some geographic location; the medium through which this may be accomplished will depend upon the references that are available. Whether the pilot chooses to follow a river or coastline to his destination, or chooses to follow a radio beam, the procedures will be identical. If he intends merely to use these aids as navigational check points while flying past, it makes little difference whether his reference is visual or aural.

In this respect it is essential that reference

be made to all available training and past flight experience of the student. Encourage him to think in terms of simple navigation, substituting radio signals for visual check points. Since radio range navigation consists primarily in flying from point to point in the most effective possible manner, range signals will be used as aural check-points in the absence of adequate visual reference. To speak in such terms is to use a language with which the student is already familiar. As closely as possible an analogy between contact flight procedures and radio procedure must be made, and in no case should radio range procedure appear obviously contradictory to contact navigation procedure.

- b. Consult Section 2, T.O. 30-100B-1 for reference in discussion of principles of operation and function of radio range. Discuss the following and ascertain that the student understands completely radio range phenomena and their use in radio navigation:

- (1) Principles of operation.
- (2) Transmission of quadrant signals and their lobe shapes.
- (3) Formation of on-course.
- (4) Types of range installation.
- (5) Voice transmission and how it is accomplished.
- (6) Range irregularities.
- (7) Auxiliary radio facilities and their use.

A class-room type demonstrator will be used in conjunction with all discussion of the

radio range and the procedures to be employed.

- c. Explain to the student that the frequency of the range station he desires to use and its letters of identification may be found in T.O. 08-15-1. At intervals of approximately 30 seconds, a radio range station will broadcast its identification signal. Caution the student to check carefully the station identification signal and not to rely upon the approximate indication of the frequency band. Two important factors should be kept in mind when tuning for maximum reception. First, having recognized the desired station identification signal, the tuning crank should be turned slowly back and forth across a narrow band on either side of the desired frequency. The student should check carefully for any undesirable "leaks" or interference from other stations, the frequencies of which are close to that of the station being used. He should further note the approximate band within which such interference is at a minimum. Secondly, the Student must tune for maximum clearness of signal by carefully listening to the station signals while swinging the crank slowly back and forth.

2. LESSON IN AIRPLANE.

- a. The student will repeat the standard instrument check over the interphone.
- b. The student will make an instrument take-off and execute climbing turns to working altitude.

- c. In the review of basic instrument flying the student will execute the following maneuvers:

- (1) Straight and level flight.
- (2) Climbs and climbing turns, given rate turns, etc.
- (3) Descents and descending turns, given rate turns, etc.
- (4) Turns to predetermined headings.
- (5) Patterns A and B.
- (6) Recovery from unusual attitudes.

The student may require more time to practice basic maneuvers to attain desired proficiency. This extra time will be given before proceeding with radio range familiarization. Should the student's basic proficiency prove weaker than average, it will be necessary to omit radio and concentrate upon basic maneuvers. Lesson I will be repeated in entirety when proficiency warrants.

- d. When reaching the working area, have the student tune in several stations in the vicinity, using his radio facility chart from which to obtain the correct frequencies. Encourage the student to experiment extensively with such tuning procedures. Do not permit him to accept the first signal obtained without careful check.
- e. Make certain that the student has available a beam chart to which to refer. Remind him of the position of the aircraft with respect to the station and to the range pattern at regular intervals. At all times encourage a complete perspective of the locality in which

the aircraft is flying. Leave no doubt that the student has obtained a proper perspective.

- (1) Select one of the quadrants of the range to be used and call the student's attention to the fact that within the center of the quadrant a clear "A" or "N" signal is obtained with no background signal from the adjacent quadrants. Maintaining a constant volume setting, fly a course perpendicular to one of the legs of the range and call the student's attention to the gradual development of a background signal as the beam is approached. Remind him of the fact that as the aircraft approaches the leg, the signal strength from both quadrants will become more nearly equal. The on-course or steady hum without a noticeable quadrant signal is that area in which reception of both quadrants is exactly the same. As the beam is crossed a faint quadrant signal will be heard, which signal will become increasingly distinct as the aircraft continues into the quadrant. When the center of the quadrant is approached, no background signal will exist.
- (2) Repeat the above procedure and call to the student's attention that the volume of the station identification signal of each quadrant will vary with the position of the aircraft with respect to the on-course. Following an interval of thirty seconds of quadrant signals, the station identification signals will be transmitted, first from the "N" quadrant and

secondly from the "A" quadrant. Since the steady hum of the bi-signal becomes easily submerged in receiver noise or static interference, the station identification is more readily recognized in conditions of static. Demonstrate to the student how the changing intensity of the station identification signals will provide an accurate indication of position with respect to the on-course.

- (3) Fly through the on-course again from the center of the adjacent quadrants on a heading perpendicular to the beam and demonstrate to the student the effect of volume control upon the intensity of bi-signal. Explain to him that the edge of the bi-signal zone is not a singular parabolic line, but is rather a function of receiver sensitivity and volume control. Demonstrate to the student that the minimum bi-signal may be adjusted to the position of the aircraft by altering the audio setting of the receiver in the major portion of the quadrant.
- (4) Demonstrate to the student beam approaches to the cone at various altitudes and call his attention to the relation of the cone of silence to altitude. Demonstrate at least one high cone and one low cone. Point out the fact that the volume must be turned down low as an added check for cone passage, since the low cone may be difficult to distinguish, particularly if the station identification signal is transmitted when passing over the station.

f. Demonstrate the relation of build and fade of volume to distance from the station. Point out the fact that as the aircraft approaches the

cone, volume increases per mile close to the station is considerably greater than at a distance. Demonstrate the rapidity of fade after passing the cone and demonstrate further the fact that such fade is more easily recognized when the volume is turned to a minimum level.

- g. Return to the field, the student making a constant let-down. Land and discuss pertinent points of the lesson.

LESSON II

OBJECTIVE

To instruct the student how to intercept and follow known beam, to bracket wind-drift correction, and to recognize when the aircraft passes the station.
To teach procedure turns.

1. BEFORE TAKE-OFF.

- a. Review principles of previous lesson.
- b. Explain proper method of intercepting and following a known beam.
- c. Explain methods of identifying station passage.
- d. Explain procedure turns.

2. LESSON IN AIRPLANE.

- a. Student repeats cockpit check over the interphone.
- b. Student makes instrument take-off and climbs to working area.
- c. Demonstrate proper method of intercepting a known beam.
- d. Demonstrate beam following, bracketing of drift correction, and the importance of directional control.
- e. Student practices interception and beam following.

2 LESSON #2

- f. Demonstrate how passage over the station may be determined.
- g. Demonstrate procedure turns.
- h. Constant letdown to field; land and hold critique.

BEAM FOLLOWING AND INTERCEPTION

INSTRUCTOR'S GUIDE TO LESSON II.

1. Before Take-Off.

- a. In the presentation of beam following, emphasis must be placed upon the point to point nature of radio navigation and not upon a formula for beam bracketing. Review the principles of range navigation briefly and emphasize the fact that consistent directional control is at the core of effective navigation.
- b.. Develop a comparison between the student's previous attempts at contact navigation and the problem of beam following with which he is confronted. Have the student explain the procedures that he would expect to use in contact flight navigation when attempting to maintain a desired track. Substitute the range on-course for the desired track and explain that the same procedures for correction of wind drift and compass error apply to beam following. Caution the student that the greatest difficulty encountered in radio range navigation is a result of excessive cor-

rection. Encourage the student to retain the perspective of contact navigation and explain the most effective procedures for beam following.

Within the on-course the pilot will fly the published heading of the beam corrected for known wind drift and compass error. As long as the on-course signal is retained it is apparent that further correction is unnecessary. The first quadrant signal obtained will provide the indication that correction is required and the procedure for correction will be accomplished as though the student had recognized an off-course check point and wished to return to the desired track. If the drift off-course has been rapid, the correction will be substantial. Point out that a correction of 30° will be sufficient for a cross-wind one half the airspeed of the aircraft. When the aircraft has returned to the desired course, a new beam heading will be taken up with further correction for wind-drift or compass error applied. Call to the student's attention that each such correction must be systematically reduced by bracketing the correction. Warn him against aimless wandering. He must know positively what each correction has accomplished.

The next problem to bring to the student's attention is that of beam interception. Point out to the student that the usual angles of interception of a

range leg are approximately 45° and 90° . The mean angle of interception of all ranges when approaching on the average bi-sector is 45° . An angle of interception of approximately 90° is used when the pilot desires to select one leg in preference to another, by flying parallel to the undesired beam. When the pilot is at a considerable distance from the station it will be possible to turn to the heading of the beam after having entered the on-course and still retain an on-course signal. Explain to the student that in such maneuvers as holding and stacking procedures, anticipating of the beam is necessary in order to make certain that the student is on-course when the heading of the beam has been obtained. Permit the student to intercept the beam close to the station and require that he anticipate the on-course slightly when starting his turn to the beam heading. When the pilot is within ten miles of the station the usual radius of turn of modern aircraft will bring the aircraft through the beam before the turn is completed, unless the on-course is anticipated and the turn begun early.

- c. Effective volume control provides the most adequate check of station passage. Explain to the student that the volume must be kept at a minimum level while approaching the station. The cone of silence provides an excellent check for arrival over the station. It can be readily distinguished from false cones

or fades in that latter are not preceded by a rapid surge of volume.

A cone check is necessary only when the rapid change of signals during station passage or the cone of silence are insufficiently clear and leave the student in doubt as to his immediate position in relation to the range station. This situation may arise if the range signals are interrupted by voice transmission during approach to the cone, or if the station identification signal occurs during low cone passage. High level of static or other interference may leave the student in doubt as to passage of station. In any such case, station passage may be determined readily by the rapid decrease in volume as the aircraft flies away from the station, but only if the volume has been constantly adjusted to minimum level during the approach. If doubt persists, the aircraft must be turned to the right of the course a maximum of 15° and the resulting change in signals noted. When opposite legs are not reciprocal, the check for station passage must be increased accordingly. Due to the blanketing effect of the aircraft engine or structure while approaching the station, there may be a momentary increase in volume after passing the station. However, its duration is so brief that the following fade will not be mistaken if a low volume level has been maintained.

d. A procedure turn is a 180° reversal of

direction to a desired track. Standard procedure turns during holding are executed to the left when outbound unless local terrain conditions dictate otherwise. The corrected heading of the leg is determined during outbound bracket in which the drift correction is apparent to the pilot. The initial turn is made 45° to the left of the corrected heading of the beam. This heading is maintained after passing the left hand edge of the beam from 45 to 60 seconds, depending upon the direction and amount of drift correction. If the original drift correction while on course is to the left, a longer period of time will be spent flying away from the beam than under those conditions in which the correction has been to the right.

After having maintained the 45° off-course heading for approximately 45 seconds, a standard rate turn is made to the right to the reciprocal heading plus or minus opposite drift correction. Caution the student of the fact that wind corrections are reversed when the heading of the ship is reversed. Upon the completion of the turn the aircraft will be close to the in-bound right-hand edge of the beam. The student must be advised of the necessity for applying beam anticipation as the on-course builds up in order to obtain the desired beam heading within the on-course. The same bracket procedure to the cone of silence is employed as learned previously.

Procedure turns at the cone of silence are made to the right, unless otherwise directed. The same correction for wind is used as in the previous procedure. Caution the student against excessive bracket in attempting to pass over the cone of silence at the completion of the procedure turn.

2. Lesson in Airplane.

- a. The student will repeat the standard cockpit check over the interphone.
- b. The student will make an instrument take-off and climb to the working area.
- c. Demonstrate the proper method of intercepting a beam. Show the student how the aircraft may be turned to the heading of the beam when at a sufficient distance from the station without danger of crossing the leg before completing the turn. Demonstrate the necessity for anticipation of the on-course when intercepting the beam close-in.
- d. Throughout all demonstrations it will be necessary to remind the student of his location with respect to the station. The student must be permitted to develop and retain throughout the flight an accurate perspective of the range pattern, and the constant changes of his position within that pattern. Select one of the legs of the range on which crosswind is at a minimum and fly to a point within the on-course. Have the student take up

a heading which will bring him to the station and hold that heading as constant as possible, making no correction. It may be necessary to take into consideration wind-drift and compass error in determining the required heading, which consideration must be made by the instructor before the maneuver is begun.

While approaching the station, remind the student of the build in volume and encourage him to retain a low volume level as a check for station passage. Permit him to make as many contact references as necessary to convince him that the track desired is being very closely approximated. Should the aircraft drift off the on-course, call his attention to that fact that the intensity of the quadrant signal as he approaches the station may be misleading and that eventually he will pass fairly close to the cone of silence. If the heading remains constant, the rapid change of quadrant signal as he passes over the cross-leg will indicate station passage.

When the student has satisfactorily completed the above maneuver, point out the necessity of determining wind-drift and compass error corrections while making his approach to the station. Fly out to a point on a leg on which cross-wind is more noticeable and demonstrate the bracketing of corrections required to maintain the on-course.

Begin with the published heading of the beam to be used and maintain a constant heading until a quadrant signal indicates having drifted off-course. At this point the same type of correction will be made as would be necessary when the pilot recognizes a check point which indicates that he is off-course. A correction will be made back to the beam, and the original heading will be corrected slightly in the opposite direction of drift.

The first alteration of heading in order to return to the beam will be a substantial correction. However, point out that each correction thereafter must be systematically reduced. Call to the student's attention that a correction of thirty degrees will provide sufficient correction for a cross-wind one-half his airspeed. In any question raised concerning the proper procedure for corrections of heading, it should be possible for the instructor to refer to the student's navigational training since the procedures are essentially the same.

The same procedure should be repeated until it is apparent that the student is able to control volume adequately and to maintain a constant heading in spite of other distracting factors. Following such demonstration, the student will practice beam interception and bracketing to determine correction for wind-drift and compass error. A check will be made of the student's ability to maintain constant headings within the on-course and

to make systematic corrections when drifting off. Encourage the use of minimum volume control throughout such bracketing.

- e. When confidence has been obtained and when the student appears sufficiently relaxed, repeat the same maneuvers with the directional gyro off-set slightly from the magnetic compass heading. The magnetic compass will be covered and the student's directional gyro caged until the instructor has disoriented the student by shallow turns to the left and right. With the directional gyro offset approximately ten degrees, the student will repeat the bracketing until satisfactory proficiency has been obtained.

Before beam procedures may be demonstrated to the student, the instructor must ascertain that the student has developed adequate comprehension of beam interception and bracketing. Provide sufficient practice in the above maneuvers to assure complete understanding. It will be noted, however, that holding and stacking procedures are basically a series of beam interception and bracketing maneuvers and will in themselves provide opportunity for practice in procedures covered in previous lessons. The instructor will use the following lesson to analyze and evaluate the student's beam technique.

- f. Re-emphasize the necessity for adequate

volume control in beam following. It will be necessary to demonstrate a cone check to the student. Demonstrate further that excessive banking close to the station introduces false signals due to the directional characteristics of the aircraft antenna and caution the student against such banks.

- g. Demonstrate procedure turns between the station and a point at a definite line outbound on one of the range legs. Since "holding" is essentially a combination of procedure turns, sufficient practice may be obtained by having the student "hold" on a specified leg between the station and a point four minutes outbound. "Stacking" may be readily simulated by a "stepping down" procedure at intervals of one thousand feet during such "holding".
- h. Return to the field, having the student maintain a constant rate descent.

LESSON III

OBJECTIVE

To teach the student the elements of Radio Range Orientation.

SEQUENCE OF INSTRUCTION

1. BEFORE TAKE-OFF.

- a. Review any points of previous lessons not clear to the student.
- b. Explain the purpose and principles of Radio Range Orientation.
- c. Explain the identification procedures of Radio Range Orientation used:
 - (1)... to identify position North, East, South or West of the station by a Fade or Build.
 - (2)... to intercept and identify a leg of the range.
 - (3)... when the aircraft is close to the station.

2. LESSON IN AIRPLANE.

- a. Student repeats cockpit check over the inter-phone.
- b. Student makes instrument take-off and climbs to working area.

- c. Demonstrate radio range orientation procedures.
- d. Student does orientation problem.
 - (1) Contact.
 - (2) Under the hood.
- e. Constant rate descent to field; land and hold critique.

ELEMENTS OF ORIENTATION

INSTRUCTOR'S GUIDE TO LESSON III

1. BEFORE TAKE-OFF

- a. Review briefly material of previous lessons and clarify any points in which the student indicates doubts.
- b. Range orientation consists basically of a systematic elimination of all conflicting possibilities of position in relation to a radio range station. As such, it must be considered in terms of the elements of orientation required to define specific relationships between the aircraft and the range pattern in which the pilot is attempting to orient himself. Orientation procedures in themselves are by no means emergency resorts and should not be considered as such. Practical radio range navigation will inevitably contain various elements of orientation depending upon the pattern of the ranges involved, and the nature of the navigation flight. A radio

navigation flight consists of a series of orientation procedures in which the pilot has available numerous possibilities such as check of cross-fixes or cones of silence, volume builds and fades and other identification procedures. It will be the instructor's responsibility to see that the student understands the more important procedures and knows when and how they are to be executed.

- c. In discussion of quadrant identification, it will be necessary to recall to the student the formation of range patterns and to explain that understanding of how the pattern is formed will aid in understanding what the following procedures will accomplish. Having obtained the desired station signals, the pilot will check the quadrant signal. If an on-course is being received, the orientation procedures will have been simplified. The pilot will immediately turn to the nearest average bi-sector and hold the heading until a quadrant signal is obtained. A 90° turn to the left will identify the leg upon which orientation procedures have been initiated.

If a quadrant signal is being received, the pilot will be expected to check for his proximity to either beam, since the procedure to be employed may depend upon his approximate position within the quadrant. The pilot will immediately turn to the nearest average bi-sector of the quadrant within which he has located himself. The volume control will be adjusted so that a minimum bi-signal is obtained. If no bi-signal can be heard within a reasonable level of volume, it is apparent that the aircraft is not close to either leg. In this

event, the pilot will decrease the volume to a minimum level and check for a build or fade of total volume. At least two checks must be made to make certain whether the aircraft is flying towards or away from the station. If the bi-signal or background signal can be identified within a reasonable volume level, the pilot will tune for minimum background and will check for a build or fade of that background. At least two checks will again be made to ascertain the direction of flight with respect to the station.

Following identification of the quadrant, the student must either select one of the legs on either side of the quadrant or approach the station and indentify the first leg he intercepts. In the former case, the student will take up a heading parallel to the undesired leg. However, beam selection of this nature must not be attempted unless the student is fairly close to the center of the quadrant. Bring to the student's attention the fact that a heading parallel to the undesired leg is not economical in terms of time.

Less time is occupied throughout the orientation procedure in using the average bi-sector. The student will maintain the average bi-sector heading retaining a low volume setting while approaching the station. As the on-course is neared the student will check carefully the sweep-second hand of the clock to determine the time required to cross the beam. If the total time is less than seven seconds, the student will immediately take up the outbound heading of one of the legs. If

the total time is more than seven seconds, the student will immediately turn 90° to the left to identify the leg.

Preparatory to range orientation, explain procedures for identification of a beam when interception is made along the average bi-sector. When approaching one of the legs of the beam from a quadrant, point out to the student that the signal reception will be the same for interception and crossing of either leg while a constant heading is being maintained. After having crossed the leg to the opposite side and the signal from the quadrant is received, a 90° turn to left will be made. If re-entry is made into the on-course, the leg to the right of the original heading has been intercepted. If re-entry is not made into the on-course, the leg to the left of the original heading has been crossed.

Explain to the student that the beam formed by the overlap of quadrant signals is, for practical consideration, a narrow wedge the angle of which is approximately 3° . When the angle of interception of the leg can be closely approximated, the width of the beam will provide an indication of distance from the station. The average angle of interception when approaching a station along the average bi-sector is 45° . Explain that an approximate estimate may be made of the time from the station by multiplying the time required to fly across the beam at this angle by thirteen.

Caution the student that it is not intended that accurate E.T.A.'s to the cone of silence be made, but that the necessary procedure to be used will be governed by the approximate estimate. A one minute flight across the on-course will require approximately thirteen minutes flight to the station. Interception of the desired leg at a heading perpendicular to the beam will mean a ratio of nineteen to one. One minute flight through the beam at an angle of interception of 90° will require nineteen minutes of flight to the station.

It should not be the intention of the instructor to require that the student establish definite E.T.A.'s to the station, but a more accurate perspective of location of the aircraft with respect to the station will be developed when he is aware of the ratio of beam width to distance from station. The importance of on-course timing will become apparent when close-in procedure is being taught. The student must be made aware of the fact that beam interception may be made too close to the cone of silence for practical bracketing. If the time required to cross the leg at 45° angle of interception is seven seconds or less, the student must immediately take up an outbound heading of one of the legs. If the time required to cross the leg at 90° is five seconds or less, it will again be necessary to use the close-in procedure.

. LESSON IN AIRPLANE.

- a. The student will repeat the standard instrument check over the interphone.

- b. The student will make an instrument take-off and execute climbing turns to working altitude.
- c. Direct the student to a position within one of the quadrants and demonstrate how his approximate location with respect to the center of the quadrant may be determined by a check of the extent of volume necessary to obtain a background signal. Demonstrate the use of the background signal in determining the approximate direction of flight with respect to the station. Demonstrate further the proper procedure in checking for build or fade of total volume. Check closely the student's control of volume level and make certain that he understands such procedures fully.

Demonstrate to the student how selection of a desired leg may be accomplished, if necessary, by flying parallel to the undesired leg. Demonstrate further the procedures to be employed in identifying a leg when approaching the station on the heading of the average bi-sector of the quadrant. Permit the student to practice the above maneuvers until reasonable proficiency has been obtained. The instructor must ascertain that the student has successfully grasped the beam following procedure of the previous lesson. If any doubt exists as to the student's proficiency, additional practice will be given in simple bracketing. Tuning technique must be carefully watched to make certain that the student uses adequate care in eliminating interference of undesirable signals and obtain maximum clarity of signal reception. When bracket technique has been accomplished satisfactorily, demonstrate to the student interception of a leg and the relation of beam width to the dis-

tance of the aircraft from the station. Have the student intercept the beam at a predetermined angle of interception and time the on-course carefully. After passing through the beam turn back into the on-course and follow the leg to the cone of silence. Compare the actual time required to reach the station with the computed time. Repeat the same maneuver using both 90° and 45° angles of interception until the student is reasonably proficient. Remind the student that, if the time across the beam is less than seven seconds with an angle of interception of 45° , the student immediately uses the close-in procedure. Permit the student to practice until he is proficient in determining procedure on the basis of timing the on-course. Repeat the demonstration if any difficulty is encountered in recognition of signal change.

- d. Have the student begin an orientation problem from one of the quadrants requiring him to identify the quadrant, the beam intercepted, and to locate himself above the station. The student will engage in a brief period of basic maneuvers until he has become reasonably disoriented with respect to the location of the radio station. He will select the proper station and make a careful check of the reception. Caution the student of the danger of improper tuning and demand that he exercise adequate care. He will be expected to check the station identification signal carefully and to eliminate all interfering signals if possible.

LESSON IV

OBJECTIVE

To teach the student the True-Fade System of Orientation.

SEQUENCE OF INSTRUCTION

1. BEFORE TAKE-OFF.

- a. Review all procedures and lessons covered thus far.
- b. Explain the purpose of the True-Fade System of Orientation.
- c. Explain the procedures to be used when working a True-Fade Orientation problem.

2. LESSON IN AIRPLANE.

- a. Student repeats cockpit check over the interphone.
- b. Student makes instrument take-off and executes climbing turns to a working altitude.
- c. With the hood open, instructor demonstrates True-Fade Orientation.
- d. Student works True-Fade.
 - (1) Contact.
 - (2) Under the hood (repeat until period of time is expended.)
- e. Constant let-down to field; land and hold critique.

TRUE-FADE ORIENTATION

INSTRUCTOR'S GUIDE TO LESSON IV.

1. Before Take-Off.

- a. Review all material covered in previous lesson and make certain that the student has a complete understanding of orientation procedures.
- b. It is imperative that the student have available sufficient understanding of radio range navigation to permit him to orient himself with respect to a range station under all possible unknown conditions. Whether the condition be a result of exceptional winds aloft of unknown direction and velocity, unreported changes of range facilities such as shifted legs, or whether it be due to compass error or malfunctioning, it is apparent that all such conditions may be satisfactorily negotiated if the student is able to demonstrate proficiency without the aid of a magnetic heading reference since, for all practical purposes, an "unknown" range is the extreme of such extraordinary conditions.

This lesson is intended to provide the student with a well-organized procedure for orientation which is applicable to all radio ranges under all unknown navigable conditions. It is also intended to increase his confidence in radio range following since the identical technique is employed as has been taught throughout the course.

- c. Orientation procedures will be begun by turning to the average bi-sector and identifying the quadrant in which the pilot is located, using the change in bi-signal if possible. If the bi-signal is not available within a practical volume level, the pilot will adjust volume to a minimum level and check for a build or fade of total volume.

The pilot will fly towards one of the legs or towards the station until the increase in background indicates nearing the on-course. Call to the student's attention that the initial quadrant signal will be the left-hand signal when he begins to follow the leg. Upon obtaining the on-course a turn will be made 90° to the left and a constant heading maintained while on-course. The first quadrant signal received will complete the major portion of the student's bracketing. When a quadrant signal is received indicating having left the on-course, a turn will be made either to the initial heading or its reciprocal, since these are the only headings with which he is acquainted. If the left-hand signal is obtained, the student will turn back to his original heading; if the right-hand signal is received he will turn to its reciprocal. When the on-course is again obtained, the student will once again average out the headings with which he is familiar and will maintain that heading until he drifts off-course. The procedure will be repeated systematically in exactly the same manner. It will be noted that the technique involved is the same as has been developed in simple known beam following with the single exception that larger

corrections are initially employed. In this respect it can be stated that the extent of doubt as to conditions of wind drift, compass error or such other conditions will determine the extent of the corrections applied.

Call to the student's attention the fact that two possibilities exist of direction of bracket with respect to the range station. Whether the aircraft is being flown towards or away from the station may be determined by the build or fade of volume during bracketing. Should the volume fade, a procedure turn will be executed. However, it is imperative to caution the student of the effect of wind drift in procedure turn. When the direction of flight is reversed, wind correction must also be reversed. Since wind correction is unknown, the student must be prepared to make fairly large corrections if the aircraft drifts off the on-course in a short period of time. Corrections must be systematically reduced during bracket to the station.

2. Lesson in Airplane.

- a. The student will repeat the standard cockpit check over the inter-phone.
- b. The student will make an instrument take-off and execute climbing turns to a working altitude.
- c. With the hood open, the instructor will demonstrate the True Fade System of orientation.

The magnetic compass will be covered and an arbitrary heading selected on the directional gyro within 45° of the magnetic heading. Such an offset will obviously simulate the most extreme in unknown conditions. Describe each procedure carefully and make certain that the student appreciate the significance of each. When approaching the on-course from the quadrant, remind the student that the signal being received will be the left-hand signal during beam following. No change in beam following has taken place and the student will employ the same bracket technique in finding the corrected heading of the beam. Encourage him in developing a mental picture of the procedures being executed.

- d. Permit the student to practice a complete orientation both contact and under the hood until the procedures have been thoroughly assimilated.
- e. Return to the field having the student maintain a constant rate let-down. Land and discuss any questions the student may raise.

LESSON V

OBJECTIVE

To continue practice of orientation procedures. To teach instrument let-down and low visibility approach.

SEQUENCE OF INSTRUCTION

1. BEFORE TAKE-OFF.

- a. Review any points of previous lessons not clear to the student.
- b. Explain instrument let-downs, and pull-ups from low approaches.
- c. Explain low visibility approaches.
- d. Define and explain standard voice procedures.

2. LESSON IN AIRPLANE.

- a. Student repeats cockpit check over the interphone.
- b. Student makes instrument take-off and climbs to working area.
- c. Student orients himself on radio range.
- d. Initiate voice procedures.
- e. Demonstrate an instrument let-down and low approach, and pull-up from low approach to emergency altitude.
- f. Demonstrate low visibility approach.

g. Students repeats the above.

(1) Contact.

(2) Under hood.

h. Student works a complete orientation problem and makes an instrument let-down low approach.

i. Return to field; land and hold critique.

LET-DOWN AND LOW APPROACH

INSTRUCTOR'S GUIDE TO LESSON V.

1. Before Take-Off.

- a. Review previous lessons with particular emphasis upon orientation procedures. Clarify all points related to previous discussion with which the student may still be in doubt.
- b. Emphasize the importance of instrument let-down in radio navigation and call to his attention the fact that, in spite of well-executed orientation procedures and efficient beam following, the mission cannot be considered a success until the pilot has successfully completed a let-down procedure and landed. The instrument let-down or low approach is one of the most important phases of all instrument flying training. It makes use of everything the student has learned up to this point and requires that he exercise all the technique and judgment at his command. Precision

ing is more essential in making a low approach than in any other flight procedure.

Stress the fact that the most important single consideration in making low approach is the minimum safe altitude. The Student must be convinced that, once a minimum altitude has been selected, he should under no condition descend below that altitude unless sustained contact reference is possible. Discuss the minimum terrain clearance upon which initial approach and final approach minimum altitudes are obtained. Select a few typical examples of let-down procedures from T.O. 08-15-3, discuss such factors as radio facilities and terrain features, and the procedures developed on the basis of these considerations. Describe how minimum altitudes may be derived for stations not included in regularly published procedures.

Discuss essential voice communication prior to execution of low approach. The pilot will be required to call the range station or tower for instructions. He must know the ceiling, visibility, surface wind and altimeter setting, since these factors all enter into his decisions during the procedure. Altimeter setting is of particular importance. Review proper altimeter setting procedures and be certain the student fully understands the importance of an accurate setting. Discuss scale error and its effect upon minimum clearance.

Using a copy of T.O. 08-15-3; The Army Air Forces Instrument Let-Down Procedures, explain the basic principles of low approach which will apply to all range stations. Explain further variations in procedure and define such terms as "initial approach", "final approach", "high cone", "low cone", "minimum altitude", "emergency altitude".

Familiarize the student with the proper procedures for completing an instrument approach.

(1) The station should be approached at the flight altitude at which aircraft has been cleared by A.T.C. Since the instructor will simulate control procedures, the student must understand his own responsibility in voice communication. He will establish contact with the tower or range as soon as possible for low approach clearance and necessary flight information.

Explain that a close-in procedure may be used following station passage in order to select the desired final approach leg. The outbound heading of the desired leg will be held until a positive fade indicates that the station is definitely behind the aircraft. A 45° turn in the direction of the beam leg will place the aircraft in a position to follow the beam.

It should be brought to the attention of the student at this time that the initial approach need not be started from the leg shown in the Handbook of Instrument Let-down Procedures. The initial approach

shown on this leg merely to simplify the chart. The initial approach may be started from any leg of the beam at any altitude higher than the stated initial approach altitude.

(2) As soon as the high cone is passed the cockpit procedure for landing (with the exception of flaps) will be completed and the speed reduced to normal descending airspeed. Part of the excess altitude will be lost going away from the station toward the procedure turn.

(3) The airplane will be levelled off about 500 feet or more above the final approach altitude, depending upon terrain, and flown level through the procedure turn. In some cases, of course, all excess altitude will not have been lost by the time the procedure turn is started. In this case, it would be necessary to continue the descent during the procedure turn. The procedure turn will usually be made after the aircraft has flown about 3 minutes away from the high cone.

(4) The completion of the procedure turn marks the beginning of the final approach. Descent should be made to the final approach altitude, and the beam followed carefully. Caution the student against permitting excessive volume build as he approaches the station, since volume control is the most effective guarantee of recognition of cone passage.

(5) The final descent to the minimum

altitude should be started as soon as the low cone is reached, unless other directions are given on the chart in T.O. No. 08-15-3. Remind the student that the crossing of the low cone does not complete the let-down, but that a constant heading must be maintained and a careful check of range signals made so as to make possible the necessary correction to the field. Caution the student not to descend too rapidly unless he is sure the terrain is level between the station and the field. Explain that it is desirable to reach the minimum altitude just before arriving over the field.

(6) If it is not possible to establish visual contact within 30 seconds a pull-up should be made immediately. Inform the student that, once the decision has been made, there should be no hesitation in starting the pull-up. The power should be increased to climbing R.P.M. and manifold pressure, the landing gear raised, and a climb started to the specified altitude. Point out that the ground control must approve another attempt or clear the aircraft to the alternate airport.

- c. Under conditions of poor visibility, it is often difficult to stay within sight of the field, even after a successful low approach has been completed. This is especially true if it is necessary to fly around the airport in order to land on the specified runway. This happens most frequently in large, heavy aircraft which require a large radius to turn. To avoid losing sight of the landing field

while in the traffic pattern, the student must learn some system for making low visibility approaches. The following system will work under almost all conditions, if modified to suit the terrain and type of aircraft.

Explain to the student that he will fly along the desired runway in the opposite direction to which he intends to land, and check his gyro heading. After the edge of the airport has been passed, he will turn 45° to the right or left of this heading, depending on wind and terrain, and fly for 40 seconds. He will then begin a standard rate turn back toward the runway. This turn is continued until he reaches the landing runway heading. The landing approach may then be started at any time, depending upon the altitude and terrain. It should now be necessary only to make small corrections to line up with the runway.

Caution the student that wind must be considered in this procedure turn, as in any procedure turn. A strong cross wind may shorten or lengthen the time on the 45 degree heading.

- d. Consult T.O. 30-100B-1 for the standard position reports and discuss voice communication with the student. Make certain that he realizes the importance of complete, clear, and rapid identification of aircraft and its location.

2. LESSON IN AIRPLANE.

- a. The student will repeat the cockpit over the inter-phone.

- b. The student will make an instrument take-off and climb to the working area.
- c. Have the student begin an orientation while heading towards the range station. Arrange the position of the aircraft so that a close-in procedure will be necessary and check the student's judgment in selection of proper procedure.
- d. In order to continue to encourage the development of a thorough perspective of range procedures, the instructor will initiate voice procedures requesting position reports at regular intervals. Make certain the student is able to give complete reports without hesitation and to make such reports intelligent to the average radio operator. When proficiency of the student warrants, position reports will be requested during critical situations, such as immediately before cone passage, to impress the student with the necessity of rapid and clear voice communication, to analyze his ability to continue range procedures in spite of distractions, and to analyze his resort to procedures to check of cone passage when necessary.
- e. Following a satisfactory orientation, demonstrate a low approach to the field and an emergency pull up. It may be necessary to designate an arbitrary altitude as field elevation, or to use a known area on a leg other than the one on, or near which the field is located.
- f. Select a proper area and demonstrate a low

visibility approach.

- g. Have the student practice with open hood until he understands the maneuver. Allow the student to repeat the maneuver under the hood until sufficient proficiency has been developed.
- h. The student will begin an orientation problem and complete low approach to the field or suitable area. Permit the student to open the hood when the approach has been completed to observe the accuracy with which he has crossed the desired location.
- i. Return to the field having the student maintain a constant rate of descent.

LESSON VI

OBJECTIVE

The purpose of this lesson is to review all the material of the course by having the student make a navigation flight entirely on instruments using radio range facilities.

SEQUENCE OF INSTRUCTION

1. BEFORE TAKE-OFF.
 - a. Review material of previous lessons.
 - b. Explain the principles and procedures of Radio Range Navigation.
 - c. Discuss flight to be made and help the student prepare maps and charts for the flight.
 - d. Review voice procedures to be used.
2. LESSON IN AIRPLANE.
 - a. Student repeats cockpit check.
 - b. Student makes instrument take-off and accomplishes the instrument cross-country.

INSTRUMENT NAVIGATION FLIGHT

INSTRUCTOR'S GUIDE TO LESSON VI

1. Before Take-Off.

- a. Before starting a discussion of the instrument cross-country flight to be made, review briefly previous work.
- b. Assuming the student has assimilated previous instruction, point out that beam following, orientation and let-downs are not taught merely to facilitate flight near the airport. Radio ranges are installed and operated to assist pilots to proceed from point to point under instrument flight conditions. Within the limits of the endurance of the aircraft, flights are not dependent upon visual reference to the terrain for long distance flights, provided there is sufficient ceiling and visibility at the destination to permit a let-down. Use this lesson to point out the function of the radio range in instrument navigation.

- (1). The student is already familiar with the use of the sectional and regional charts in navigation. He will have noticed the radio ranges overprinted on the charts. Obviously, then, he may use sectional or regional charts to assist him in an instrument navigation flight. Point out that since it has proven an impossible task to correct the radio navigation data shown on the sectional charts up to date, a specialized type of publication, T.O. No. 08-15-1, AAF Radio Facility Charts, is provided for his use. Show him this publication and explain the information published therein. Show him first the planning charts and

explain that the distance between stations is shown here, as well as danger areas to be avoided.

The area charts show the location of all radio aids to navigation, including ranges, homing stations, and marker beacons, and give the headings of all range legs. A flight on the airways may be planned and executed quite successfully by reference only to a Radio Facility Chart.

Show the student how a reference to the tabulated pages opposite each chart will also yield much valuable information. Here he will find listed such items as field elevations, tower and range frequencies, bearing and distances from stations to fields, the class of each range station, and miscellaneous remarks.

Since present Radio Facility Charts include distance between radio fixes, explain to the student the simplicity of procedure for establishing estimated times of arrival over fixes when flying airways. The student will be required to include E.T.A.'s in his position reports at all times. For all off-airways, "direct" flight, the student will be required to determine distances between fixes and compute E.T.A.'s accordingly. Running fixes may be readily employed

since it is usually possible to check E.T.A.'s by use of range legs crossing the track. It is imperative that this lesson utilize all possible knowledge of range navigation.

Explain the classification of range stations to the student. Stations are classified for simultaneous transmission by the letter "S" for type of antenna by "RA" for Adcock or "RL" for loop; for medium power ranges by the letter "M"; low power by "L"; and to indicate a station location marker the letter "Z" is added. "W" for without voice is used where voice facilities are not installed or are inoperative for extended periods.

- (2) Also, be sure to caution the student not to neglect his sectional charts when on an instrument flight. T.O. 08-15-1, being a Radio Facility Chart, does not show terrain detail. Safe flight levels along the airways are shown therein (these are not minimum flight levels along the airways within the meaning of Civil Air Regulations, but are altitudes which will provide at least a 1000 foot clearance within a strip of terrain 50 miles wide along the airways) but off airways flights, or flights at lower levels must be conducted by reference to sectional

aeronautical charts. The student should use the Radio Facility Charts as a reference wherein up to date information on radio navigational aids is obtainable.

- (3) The student is already familiar with T.O. 08-15-3, the AAF Instrument Let-down Procedures, but remind him that it should be consulted when planning any instrument flight which may terminate in a low approach at the destination.
- c. Help the student prepare for the flight. Emphasize that weather, terrain and the performance characteristics of the airplane are the determining factors in choosing an altitude. If it is practical to conduct an actual weather flight, the trip should be planned in the weather office. If it is not practical, and a hooded flight will be made, discuss the weather factors affecting actual instrument flight.

Explain that the flight altitude must always be high enough to clear all terrain within a radius of 25 miles of the flight path by at least 1,000 feet. This is the lower limit.

The upper limit will be determined by the icing level, the top of the overcast, or the location of turbulent levels. Somewhere between these two limits the altitude will be placed. Whether the altitude will be even or

odd depends upon the direction of the flight and the airways to be used, and can be determined by reference to a Radio Facility Chart.

After all these limiting factors have been taken into consideration, the altitude chosen will be the one at which the winds aloft and the performance characteristics of the airplane combine to provide maximum ground speed for the cruising power setting.

Explain to the student that this desired altitude must now be approved, with respect to other traffic, by Airway Traffic Control. ATC may direct a change of altitude or a delay in take-off if conditions necessitate this change. The student should be prepared to submit a different altitude for approval in case airway traffic conditions prevent use of the original flight level.

Help the student prepare his maps for the flight. Try to arrange the course so that at least one leg is off the airways and will require interception of a beam and orientation.

- d. Consult T.O. 30-100B-1 for the proper voice procedures to be included in all aircraft to ground communication. Explain the necessity for standardized procedures and make certain that the student understands fully all "canned" expressions and phrases.

2. Lesson in Airplane.

- a. Student repeats standard cockpit check.
- b. When all preparations are complete the student should make an instrument take-off and climb to the altitude of the first leg.

If possible, have the student contact the range stations in route using the proper voice procedure. If this is not possible, act as the range operator yourself, and have him call you, using the correct procedure.

Either a simulated or an actual low approach should be made at the field on the return, and a low visibility approach executed if practicable.

G-(E-W) — E

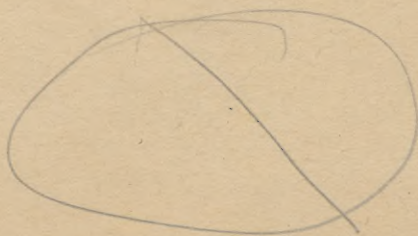
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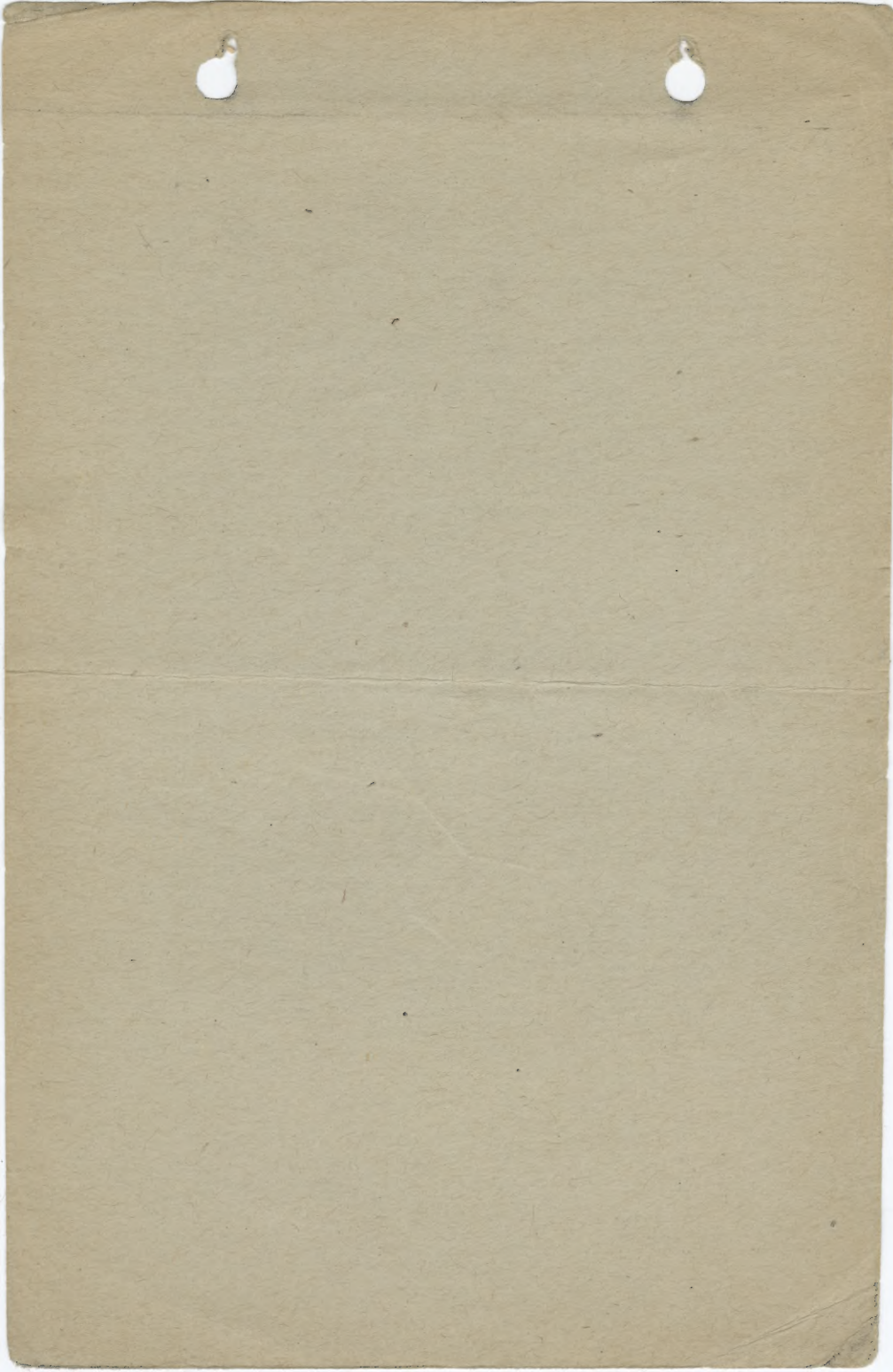
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Capt. Mason

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